

A Collection of *Centers* and use-
ful Proportions on the Line of
Numbers, by *John Brown* at the
Sphear and Sun-Dial in the Mi-
nories.

In Multiplication.

AS 1 to the Multiplier, so is the Mul-
tiplicand to the Product, consisting of
as many Figures, as the Multiplier
and Multiplicand, and sometimes of one
less, when the 2 first Figures of the Product
are greatest. And more than 4 figures in the
Product, must be adjusted by multiplication
of the last figures by the Pen or Head.

In Division

As the Divisor to 1, so is the Dividend to
the Quotient, containing as many figures
as the Divisor may be set times under the Di-
vidend by the Pen, and the fraction remaining is
a Decimal Fraction, and reduced to the Vulgar
Fraction, by setting the same extent the con-
trary way from the Decimal Fraction, gives the
Vulgar Fraction.

Of mean Proportions

The Arithmetical mean, is the half sum of
the two extremes added. A The

The Geometrical mean, is the Square Root of the Product of the two extrems multiplied together : Or the middle between the two extrems, counted on a line of Numbers.

The Musical is thus found ; As the Arithmetical mean, to one extrem, so is the other extrem to the musical mean proportion required.

Of Square and Cube Roots.

The middle between 1, and any other Number more or less than 1, is the Square Root of that Number, being measured on a fit Line of Numbers ; the exact third part between 1 and any other Number, more or less than 1, counting from 1 is the Cube Root of that Number, counted on a true Line of Numbers.

The exact fourth part, between 1 and any other Number, counted on a Line of Numbers, from 1, is the Byquadrat Root of that Number, &c.

Of Reduction.

As one Denominator to his Numerator, so is the other Denominator to the inquired Numerator.

Or, As one Denominator to the other ; so is one Numerator to the other required.

Note. That the Line of Numbers and Pence together, reduceth Decimals of a pound, to shillings and pence, and the contrary, by inspection only.

Thus

Thus, 1001 is neer 9 farthings, 1011
just 2 s. or 1,10th, of a l. or 20 s. 0125 is
2 s. 6 d. and 1,532 is 1 l. 10 s. 7 d. 2 f. 2
and so for any other; for 1 is 1 l. 05 is 10 s.
and just against 032 is 7 d. 2 f. 2 the exact
Reduction.

In the Rule of Three Direct.

As the first term, to the second, so is the
third to the fourth required.

Or, As a greater to a less, so is another greater
to another less, extending the same way,
from the third to the fourth, as from the first
to the second.

And so the contrary, As a lesser term to a
greater, so is another less to another greater
extending the same way.

In Superficial Measure.

1. As the breadth in inches to 12, so is 12
to the inches long to make 1 superficial foot.

2. As the breadth in foot measure to 1, so
is 1 to the length in foot measure, to make 1
foot of Superficial measure.

3. As 1 to the length in feet, so is the
breadth in feet to the content in feet.

4. As 12 to the breadth in inches, so is the
length in feet to the content in feet.

5. As 1 inch to the breadth in inches, so is
the length in inches to the content in inches.

6. As 144 to the breadth in inches, so is

the length in inches to the content in feet.

Of Land-measure.

1. As 9 to the length in feet; so is the breadth in feet to the content in yards.
2. As 14 f. 0625 the feet in a Square Ell to the breadth in feet, so is the length in feet, to the content in Superficial Ells.
3. As 1 Perch to the breadth in Perches, so is the length in Perches, to the content in like Perches; 16 foot and a half to a Perch.
4. As 160 (the Perches in 1 Acre) to the breadth in Perches, so is the length in Perches to the content in Acres.
5. As 10 to the breadth in Chains and Links, so is the length in Chains and Links, to the content in Acres, (because 10 Square Chain is 1 Acre).
6. As the length of a customary Pearch, is to the length of the Statute Perch, so is the content in Statute Acres known, to the content in customary Acres required, at two repetitions or turning the Compasses twice.
7. To find by what Scale a Field is plotted, measure by a Scale as near as you can estimate, then the middle between the *Area*, found by the estimated Scale, and the Area set down in the Plot; and the *Area* found by the estimated Scale, shall reach from the estimated Scale to the true Scale by which the draught was plotted.

8. As the length of any Oblong in Perches to 160, so is 1 Acre to the breadth in Perches required to make 160 Perch or 1 Acre.

Or, As the length in Chains to 1, so is 1 to the breadth in Chains for 1 Acre.

Or, As the length in feet to 43560, (the feet contained in a Square Acre) so is 1 to the breadth in feet to make up 1 Acre.

Of Triangles.

1 As 2 to the Base, or longest side of any Triangle, so is the Perpendicular to the *Area* of the Triangle required, in like parts.

2 The sides given, to find the Perpendicular, square each side severally, then add the greatest, and least Squares together, and from the half Sum of them, subtract the remaining Square, noting the difference or remainder; half this Remainder divide by the longest side, and the quote sheweth where the Perpendicular will fall on the Base.

Then square the Quotient, and subtract it from the least Square first added, then the Square Root of the remainder is the Perpendicular required for that Triangle.

3. To find the *Area* by the sides only,

Add the 3 sides together, to get the sum and then the half sum, and then find the difference between the half sum and each side severally.

Then multiply one difference by another difference,

difference, and then this Product by the remaining difference; and lastly, this second Product, by the half Sum, after the manner of continual Multiplication.

Then Lastly, the square Root of this last Product, is the Area or Content of the Triangle required. The three sides 6, 8, and 10, have 24 for the Area.

4 All irregular many sided figures, are reduced to Triangles, by drawing of Lines, and then measured by the first Rule of Triangles, or two Triangles at once, by one common Base and two Perpendiculars.

5 Regular Polygon, of 5, 6, 7, 8, or more sides, are measured at one Multiplication, thus, As 1 to the Radius or Measure from the Center to the middle of one side, so is the half Sum of the measure of the sides to the content.

Of the Circle and Ellipse.

1 As 10, as a fixed Diameter, to any other Diameter, so is 31,416 the fixed circumference where 10 is Diameter, to the circumference required.

2 As 31,416 the fixed circumference, to any other circumference, so is 10 a fixed Diameter to the Diameter required.

3 As 10 to 8,862, the fixed side of a Square equal to a Circle, whose Diameter is 10, so is any other Diameter given, to his proportional Square equal required.

4 As

4 As 10 to 7,071 the side of the inscribed Square, so is any other Diameter to his proportional side of the inscribed square required.

5 As 8,862, to 10, so is the side of any other square equal to his Diameter required.

6 As 10 to any other Diameter, so is 78,540 the Area of a Circle whose Diameter is 10, twice repeated to the Area required.

7 As 31,416 to any other Circumference given, so is 78,540 the fixed Area, to the Area required at twice turning the Compasses.

8 The half distance on a line of Numbers, between 78,540 and any other Area given, shall reach from 10 the fixed Diameter, to the Diameter required.

And from 31,416 the fixed circumference to the circumference required.

And from 8,862 the fixed side of the square equal, to the side of the square equal required.

And Lastly, from 7,071 to the side of the square inscribed in the Circle required.

9 A mean Proportion Geometrical, between the longest and shortest Diameters of an Ellipsis, or Oval, is the diameter of a circle, equal in Area to the Oval.

Then having the Diameter, you have the rest.

10 As 100 the square of 10 a fixed Diameter, is to the Rectangle Figure made of the longest and shortest Diameters of a Oval, so is 78,540 the Area for 10, to the Area of the Oval or Ellipsis required.

11 As

12 As 452, to 355, or as 14 to 11, so is the Square of any Circle's Diameter to the Area.

13 As 1 to the Radius of a Circle, so is the semicircle to the content of a Circle.

14 As 1 to the Radius of a Circle, so is half the arch of any portion, to the Area or Superficial Content of that Portion, proceeding to the Center, as a Quadrant, a Sextance, or the like part.

15 For other segments find the Diameter of the Circle or the Radius and length of the Arch, by measuring: Or thus, First, for the Diameter of the whole Circle, Square half the Diameter, or Chord of the segment, divide the Product by the segments Altitude or Sine, then the quote and sine added together shall be the Diameter required, and half the Diameter is Radius.

2 And the Square Root of the Sum of the Segments Altitude, and half the Segments Chord, is the Chord of half the Segments Arch.

3. Lastly, the length of the Arch of the whole Segment is equal to twice the Chord of the half Segments Arch, more 1 third part of the difference between them, and the whole Segments Diameter.

Then measure the whole Segment as before by Radius and half the Arch, and then the Triangle subtracted remains the Area of the Segment required. of

*Of a Globe, or Sphear, and his Segments,
the Diameter and Circumference is the same as
in a Circle; the rest thus,*

1 As 1 to the Diameter in inches, so is the Circumference in inches, to the superficial Content round about the Sphear in inches likewise.

2 Or as 10 to the Diameter, so is 31,416 twice, to the Superficial Content round about.

3 As 1 to the Diameter, so is the Diameter twice to the Cube of the Diameter; then as 21 to 11, so is the Cube of the Diameter to the solidity.

4 Or the extent from 10 to any other Diameter, being thrice repeated from 523,60, (the solid content of a Globe of 10 inches Diameter) gives the solid content required.

5 The extent from 1 to 1,90986, the Arithmetical Complement of 523,5987, the Area of that Globe whose Diameter is 10, shall reach from the Solid Content, to the Cube of the Diameter, whose Cube Root is the Diameter required.

6 As any Gauge point, for Wine or Beer Gallons, to the Sphears Diameter, so is two third parts of the Sphears Diameter twice, to the solid content according to the Gauge Point.

7 As 1 to the Segments Diameter in Inches, so is the Segments half Altitude, less by 1, & th thereof twice repeated, to the neer solidity in inches required.

8 As 1 to the Sphears Circumference, so is the Segments Altitude, to the Superficial Content of the spherical part of the Segment.

9 As the Gauge Point for Wine or Ale Gallons, to the Segments Diameters, so is the Segment half Altitude more by one eighth of the half Altitude twice repeated to the Segments neer Content in like Gallons, to the Gauge Point.

20. As for Solid Angles of a Sphere, they are reduced to Cones or Pyramids, and so measured, but for the Superficies of Spherical Triangles, by Mr. John Leake thus,

As 1 to the excess of the three Angles above 180 deg. so is Radius, to the Superficial Content of the Spherical Triangle.

Of Cones, and Pyramids, and Prismes.

As 1 to the Area of the Base, so is one third of the Perpendicular Altitude, to the Solidity.

1 A Cone is best Gauged thus,

As the Gauge Point for round Vessels, to the Cones Diameter at the Base, so is one third of the Cones Perpendicular Altitude twice, to the Content in Wine or Beer Gallons: as the Gauge Point was,

2 To get the Perpendicular height,

Square half the Diameter of the Base; also square the Hypothenuse or slant height, then take the lesser square from the greater, and the Square Root of the residue, is the Perpendicular height of the Cone required.

3 For Prismes and Pyramids say,

As the Gauge Point for square Vessels to the side of the Square, equal to the Base of any Prism or Pyramid, so is one third part of the Perpendicular Altitude twice, to the content in Gallons, according to the Gauge Point used.

Or, As the Gauge Point for Square Vessels is to the breadth of any Prism, so is the length to a 4th. Again, As the same Gauge Point to the 4th. so is one third of the depth, to the content in Gallons according to the Gauge Point used.

A Table of Cube inches and Gauge Points for these Vessels.

Names of the Vessels.	Cube Inches	G.P. Round	GP Square
Wine Gallon at	231 0	17 1485	15 199
Corn Gallon at	272 25	18 6168	16 500
Ale Gallon at	288 00	19 1485	16 972
Ale Gallon at	282 00	18 9468	16 793
Firkin at 282 { Ale	2256 00	53 5960	47 498
{ Beer	2538 00	56 846	48 552
Kilder. at 282 { Ale	4512 00	75 798	67 180
{ Beer	5076 00	80 395	7 246
{ Ale	9014 00	107 191	95 000
Barrel at 282 { Beer	10152 00	113 690	100 558
{ Ale	9216 00	108 380	96 000
Barrel at 288 { Beer	10568 00	114 88	101 823
Corn Bushel at			
272 1, 4th, for }	2178 00	52 6666	46 668
a Gallon ;			
Coal Bushel at 280 }	2246 00	53 500	47 395
2, 4th, to a gallon, }			

The first column is the Number of Cube inches contained in any of these Vessels, and serve as Divisors to bring any great Number of Inches, to Gallons, Barrels, or Bushels, accordingly.

The Second is the Gauge Points for round Vessels, being the Diameters of Circles, whose Content at 1 inch deep, contains a Gallon, or Barrel, &c.

The Third column are Square Roots of the First Column, and thus used as Gauge Points for Square Vessels.

1 As the Gauge Point to the side of the Square of any square Vessel, so is the depth twice to the content in Gallons or Barrels, according to the Gauge Point used.

2 As the Gauge Point to the breadth of any square Vessel, so is the length to a 4th.

Again,

Again, As the Gauge Point to the 4th. so is the depth to the content as the Gauge Point was.

3. As the Gauge Point for a round Vessel is to the equated Diameter, so is the length twice, to the content as the Gauge Point was.

4. The most ready Rule for all ordinary Casks for the mean Diameter is, as 10 to 7, so is the difference of Diameters to a fourth, to be added to the least Diameter to make a mean.

Note, That in Cask neer a Cyllender, you may say as 10 to 8,50; in Cask like to Cones, say as 10 to 5,30. In Cask like a Parabolick Spindle, or Oval, say, as 10 to 6. But for very much swelling Cask, say, as 10 to 7,3; or 7,4, or 7,5. so is the difference of Diameters to a 4th, to add to the lesser Diameter, to make a mean Diameter.

Of Square Solid or Timber Measure.

1 A mean Proportion Geometrical, or the middle between the breadth and thickness, measured on a line of Numbers, is the side of the square equal.

2 As the inches square to 12, so is 12 twice, to the inches long to make 1 foot.

3 As 12 to the breadth in inches, so is the depth in inches to a 4th. Again, as the 4th. to 12, so is 12 to the inches long to make 1 foot.

4. For small timber, say, As 1 to the breadth, so is the depth in inches to a fourth.

Again, As that 4th. to 12, so is 12 to the feet and parts long, to make 1 foot.

5. As 12 to the inches square, so is the inches square to the quantity in 1 foot in inches.

6. As 12 to the breadth in inches, so is the depth in inches, to the quantity in a foot in inches.

7. As 12 to the inches square, so is the feet long twice, to the content in feet.

8. As 12 to the breadth in inches, so is the depth in inches

inches to a 4th. Again, As 12 to that 4th. so is the length in feet, to the content in feet.

9. As 1 to the breadth in inches, so is the depth in inches to a 4th. Again, As 1 to that 4th. so is the length in inches, to the content in Cube inches required.

10. As 1 to the thickness in inches, so is the breadth in inches to a 4th. Again, As 144 to the 4th. in inches, so is the length in feet, to the content in feet.

Of round Timber measure, by the Diameter.

1 As the Diameter in inches to the 13,54, (the Diameter, when one foot long makes 1 foot of Timber) so is 12 twice, to the length in inches to make 1 foot.

2. As 13,54, to the Diameter in inches, so is 12 twice to the quantity in a foot long in inches, or so is 12 twice, to the feet in a foot long. (With foot measure use 1,128.)

3. As 13,54, to the Diameter in inches, so is the length in feet twice, to the content in feet.

4. As 1,128 to the Diameter in inches, so is the length in inches twice, to the content in inches.

5. As 1,128, to the Diameter in feet and parts, so is the length in feet and parts, to the content in feet and parts.

By the Circumference.

1. As the Circumference in inches to 147,36 (the inches about, when one inch long makes a foot) so is 1 twice, to the inches long to make a foot.

2. As the Circumference in inches to 42,54 (the inches about, when 12 inches long makes one foot) so is 12 twice, to the inches long to make 1 foot : Or so is 1 twice to the feet long to make one foot of Timber.

3. As 42,54 to the Circumference in inches, so is 12 twice, to the inches in a foot long : Or so is 1 twice to the feet in a foot long.

4. As

4. As 42,54, to the inches about, so is the length in feet twice, to the content in feet.

5. As 3,545 the feet about, when 1 foot in length is a foot of Timber, to the girt in feet, so is the length in feet twice, to the content in feet.

6. As 3,545, to the girt in inches, so is the length in inches twice, to the content in solid inches.

To measure Brickwork and reduce it.

1. Note 272 foot 1 fourth is a rod of Brickwork, at a Brick and half thick, and the center for it is 1.

Centers for other thickneses are thus found:

2. As half a Brick, at 05, or as (1 Brick at 1, 2 Bricks at 2, 2 and a half at 2,5, 3 Bricks at 3,) is to 1,5; so is 1 the Center for a Brick and half to 3 the Center for half a Brick required.

3. As the Center for any thickness, is to the length in feet of any Brick-wall, so is the breadth in feet to the content in feet, at a Brick and a half thick,

4. As 272, 1 fourth to 1, so is any number of feet to the Rods, and Quarters, and Decimals; and the same extent laid the contrary way, from the Decimal Fraction gives the odd feet.

For the extent from 272, 1 fourth to 1, laid the same way from 1528 foot, gives 5 Rod and a half and 11 parts over, then the same extent laid the contrary way from 11, gives 30 foot over, in all 5 Rod and half 30 foot.

5. As 272, 1 fourth the foot in one Rod, to 5 £ the price of one Rod, so is 1528 foot to 28 £ 1 s. the price of 1528 foot at 5 £ per Rod.

6. As 0665, a point for once and half, is to the breadth of any roo, so is the length, to the content in feet on both sides (being measured in feet.)

For Digging of Earth in Square Yards

1st. As 9 to the length in feet, To is the breadth to the superficial

superficial Yards. Again, As 3 foot the depth of one Yard, to the content in superficial Yards, so is the depth in feet, to the content in solid Yards.

2ly. 1. Or plainly thus, As 1 to the length in feet, so the breadth in feet, to the superficial feet.

2. As 1 to the superficial feet, so is the depth in feet to the solid content in feet.

3. As 27 the feet in 1 yard to 1, so is the solid content in feet, to the content in solid yards.

Of Simple Interest

1st. As 100 is to 6 l. the Interest due for 100 l. in 1 year, so is any other sum to his proportional interest in 1 year.

2ly. For months count thus, If 6 be 12 months or 1 year, then 5 is 10 months, 4 is 8 months, 3 is 6 months, &c. decreasing less than 1 year; so likewise 12 is 2 year, 18 is 3 year, &c. So that for 30 months, take 15 the half of 30; &c. As 100 to 15 the interest of 100 l. in 30 months, so is any other sum to his simple interest in the like time at 6 per Cent.

3ly. For principle and interest either increase or present worth, thus at any time.

If 106 is 1 years principle and increase, 112 is 2 years, 118, 3 years: thus every tenth on the line of Numbers: is 2 months: thus,

What is the increase of 125 l. interest and principle in 40 months, or its present worth being due 40 months to come.

As 100 to 120, so is 125 to 150 l. the principle and increase in 40 months.

And if the same extent be laid the contrary way from 125, it gives 104 l. 4 s. the present worth of 125 l. due 40 months to come at 6 per Cent. simple interest.

4ly. 1. For dayes thus, As 365, the dayes in a year to the rate; so is the number of dayes, to the interest of 100 l. in so many dayes, as a 4th.

2. As this 4th, with 100 added to it, is to 100, so

in the sum propounded to the present worth; if the sum be pounds, shillings and pence, reduce it to a Decimal Fraction, and the years to dayes: Note also the same extent laid the other way, gives the principal and increase in so many dayes.

Equation of Payments

1. By the last rule find all the present worths, at the times to come, then say, as all the present worths to all the payments, so is 1 *l.* to a fourth, from which taking a unite, the remainder is the interest of 1 *l.* the time sought, which divided by the interest of 1 *l.* for 1 day, viz. 000164384, the quote is the number of dayes required.

Example,

If 220 *l.* be due at a years end, the present worth is 207 *l.* 11 *s.* 6 *d.* for the extent from 106 to 100 laid from 220, gives 207 *l.* 11 *s.* 6 *d.* But if it should be paid at 55 *l.* per quarters, when should it be paid at once to be equal between Debtor and Creditor?

As	{	$\left. \begin{array}{l} 101,5 \\ 103,0 \\ 104,5 \\ 106,0 \end{array} \right\}$	{	$\left. \begin{array}{l} 3 \text{ months} \\ 6 \text{ months} \\ 9 \text{ months} \\ 12 \text{ months} \end{array} \right\}$:: 50 is 55 to	{	$\left. \begin{array}{l} 55,20 \\ 53,41 \\ 52,63 \\ 51,90 \end{array} \right\}$	}	present worth
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The sum of them 212,14

Then as 212 *l.* 14 *s.* the sum of the present worths, to 220 the sum of the payments, so is 1 to 103,70, from which taking 100, rests 03,70, the interest of 100 *l.* the time sought. Then the 03,70, divided by 00016438 the interest of 1 *l.* 1 day, hath in the quotient 225 dayes the true time to pay the 220 *l.* at once.

Compound Interest

The extent from 100 to 106, the principal and increase in one year, repeated as many times as there be years, gives the principle and increase of any sum, and being turned as many times the decreasing way gives the present worth.

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